PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Electrical Insulation for High Voltage Conductors

We, ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET, a Swedish Company, of Västeras, Sweden, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electrical insulation for high voltage conductors, e.g. coils for high voltage electrical machines, the insulation comprising an insulating tape wrapped around the conductor in several layers and an impregnating material which fills the voids and air spaces in the insulation.

Coils for high voltage electrical machines are usually insulated with mica tape which is wrapped around the conductor, or the bundle of conductors, of the coil in several layers. Often tapes are used consisting of mica flakes which are attached to a tape-formed backing or base such as paper, silk or glass cloth. After the tape insulation has been applied to the conductor or bundle of conductors, it is impregnated, usually under vacuum, with an impregnating material which consists, for example, of asphalt or of a completely polymerisable resinous composition. The impregnation is done in order to fill the voids and air spaces occurring in the insulation as completely as possible so that the insulation is given good electrical and mechanical properties. Incomplete filling leads to internal discharges in the remaining voids of the insulation, which as a consequence of the damaging action of the discharges, limits the use of the insulation to lower voltages than the insulation would withstand if no voids existed.

It has been proved, by impregnating insulations built up in the mentioned way, that the binder in the mica tape renders the penetration of the impregnating material difficult, resulting in incomplete filling of the voids. In order to improve the impregnation it has already been suggested to use a volatile binder in the tapes which, after the tapes have been wrapped around the conductors, is volatilized before the insulation is impregnated, or to use a binder in the tapes which is soluble in the impregnating material. The use of a volatile binder, however, leads to the manufacture of the insulation being complicated and more expensive. The reasons for this are that an additional process is required for the removal of the binder and that special precautions have to be taken when storing the tapes, because of the volatility of the binder. The use of a binder which is soluble in the impregnating material is connected with the disadvantage that the impregnating process is very tedious as the impregnant cannot penetrate faster than it can dissolve the binder.

In an insulation built up of several consecutive layers of a material consisting of mica flakes attached to a backing, each layer of mica flakes is separated from an adjacent layer of mica flakes by a layer of the backing. For the materials hitherto used as backings, the relative permittivity as well as the dielectric strength is considerably lower than for mica. This leads to the fact that the greater proportion of an applied electric stress will appear across the electrically weakest component of the insulation and so the build-up of the insulation in different layers makes it impossible to make full use of the excellent dielectric strength of the mica.

In an insulation according to this invention the difficulties of impregnation and the unfavourable distribution within the insulation of the relative permittivity and dielectric strength, which existed in previously manufactured insulations, are avoided.

According to the invention an insulation for a conductor or a bundle of conductors for high voltage equipment, comprising an insulating tape wrapped around the conductor or bundle of conductors in several layers and an impregnant supplied after the wrapping

[Price 3s. 6d.]

with the tape and filling voids and air spaces in the insulation, is characterised in that the insulating tape consists of a self-supporting tape which is built up of small mica flakes overlapping each other, and which is binder-free before impregnation, and of glass fibre threads which are attached to the mica tape parallel to the longitudinal direction of the tape and which cover only a small part of the surface of the mica tape. Preferably the thickness of the glass fibre threads is smaller than the thickness of the mica tape. Preferably the threads are placed at such a distance from each other that they cover less than a tenth of the surface of the mica tape.

The binder-free mica tape may be manufactured by splitting common mica by heating it, immersing the split mica in water until a pulp of small mica flakes is formed, and then subjecting this pulp to a further treatment similar to that used in the manufacture of paper. The self-supporting mica tape consists of randomly arranged small mica flakes overlapping each other and bonded to each other by molecular forces acting between them. The task of the glass fibre threads is to increase the tensile strength of the insulating tape in the longitudinal direction. The glass fibre threads have a higher modulus of elasticity than the mica-tape and therefore the glass fibre threads aborb tensile stresses occurring while the mica-tape is almost entirely unloaded. As binder to attach the glass fibre threads to the mica tape, thermoplastic fibres, for example, can be used. The last mentioned fibres can be applied parallel to the glass fibre threads and, for attachment, be heated to the melting temperature of the thermoplastic.

Insulating tapes for use in the manufacture of insulations in accordance with the invention will now be described in more detail in the following non-limitative examples and in connection with the accompanying drawing, in which:—

Figure 1 is a perspective view of a piece of tape, and

Figure 2 is a schematic view of apparatus for performing a step in the manufacture of the tape of Figure 1. In the drawing the insulation 1 comprises a mica tape 2 having glass fibre threads 3 attached to its surface.

EXAMPLE 1

On one side of a binder-free, self-supporting mica tape 2 having a thickness of 0.09 mm and a width of 25 mm, nine glass fibre threads 3 are applied parallel to its longitudinal direction at equal distances from each other of about 2.5 mm. Each glass fibre thread consists of 102 glass fibres with a diameter of about 5μ. As a binder to attach the glass fibre threads to the mica tape, there is used, for each glass fibre thread, a 50 denier thermoplastic fibre thread consisting of 24 fibres of polyethylene gycol terephthalate polymer which, before the glass fibre thread is attached to the mica tape, is applied to the surface of the glass fibre thread by twisting together with the thermoplastic thread. The glass fibre threads are attached to the mica tape in the way shown in Figure 2. The mica tape 2 and the threads 3 of the glass fibres with applied thermosplastic fibres pass through a heating means 4 where they are subjected for some seconds to a temperature of about 300° C. so that the thermoplastic fibres melt. The melted thermoplastic material flows around at least some of the glass fibres simultaneously as it wets the surface of the mica tape. When the insulating tape, after its passage through the heating means, is cooled, the thermoplastic material passes into the solid state at about 200° C. and the glass fibre threads are then fixed and attached to the surface of the mica tape by the adherence of the thermoplastic material.

EXAMPLE 2

On one side of a binder-free, self-supporting mica tape 2 having a thickness of 0.065 mm and a width of 25 mm, twelve glass fibre threads 3 are applied parallel to the longitudinal direction of the mica tape at equal distances from each other of about 2 mm. Each glass fibre thread consists of 102 glass fibres with a diameter of about 5μ. To attach the glass fibre threads to the tape there is used a chloroprene polymer of the kind made by the Goodyear Tire & Rubber Co. under the Registered Trade Mark " Pliobond " and designated with the number " 20 ". The glass fibre threads are first coated with this polymer by using a methyl ethyl ketone solution containing 20 per cent by weight of the polymer. The coated glass fibre threads are then dried and applied to the mica tape in the way described in Example 1, the temperature of the heating means 4, however, being about 200° C.

After the insulating tape has been wrapped around the conductor the insulation is impregnated under vacuum with a completely polymerisable resin, e.g. with an unsaturated polyester resin or an epoxy resin. Because the mica tape of the insulating tape is free from binder, the impregnant can penetrate the tape and fill all voids in the insulation very well. The impregnated insulation is, before and during the curing of the impregnant, subjected to a pressure in a mould or in another way, so that excess impregnating material is squeezed out of the insulation and the mica tapes in two adjacent layers of the insulation are brought into immediate contact with each other over practically the whole surface. It is possible to achieve this result because the glass fibre threads are applied in such a way that they cover only a small part of the surface of the mica tape and because the mica tape, while the impregnating material is in a liquid state,

is soft and somewhat plastic. As a result the glass fibre threads are pressed into the mica tape when pressure is applied. The finished insulation is practically homogeneous and the mica content, which in earlier manufactured insulations with mica tapes was about 40 to 50 per cent, amounts to about 75 per cent of the total weight of the insulation.

WHAT WE CLAIM IS:—

1. Electrical insulation for high voltage conductors, comprising an insulating tape wrapped around a conductor or a bundle of conductors in several layers and an impregnating material supplied after the wrapping with the tape and filling voids and air spaces in the insulation, characterised in that the insulating tape consists of a self-supporting tape built up of small mica flakes overlapping each other, and which is binder-free before impregnation, and and of glass fibre threads which are attached to the mica tape parallel to the longitudinal direction of the tape and which cover only a small part of the surface of the mica tape.

2. Electrical insulation as claimed in Claim 1, in which the thickness of the glass fibre threads is less than the thickness of the mica tape.

3. Electrical insulation as claimed in Claim 1 or Claim 2, in which the glass fibre threads cover less than one tenth of the surface of the mica tape.

4. Electrical insulation as claimed in Claim 1, comprising the mica tape described in either of the foregoing examples.

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864719 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1

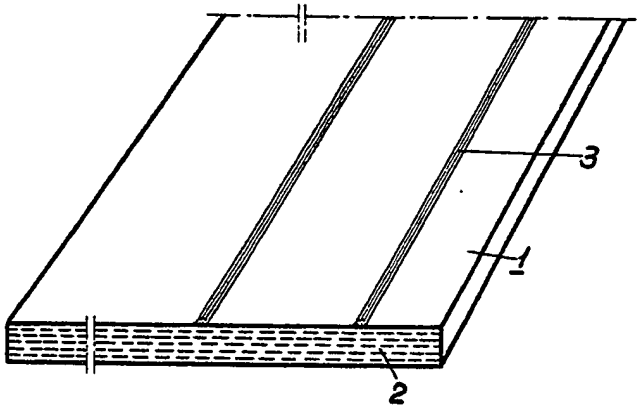

Fig.2